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Erratum: Cores in warm dark matter haloes: a *Catch 22* problem

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Table 1. Simulations parameters.

Label	m_ν (keV)	$m_{\nu,\,\mathrm{vel}}$ (keV)	N_{vir} (10^6)	M_{vir} ($10^{12}\,\mathrm{M_\odot}$)
CDM	∞	–	10.2	1.42
WDM1	2.0	1.32	8.6	1.22
WDM2	2.0	0.33	8.4	1.20
WDM3	2.0	0.13	8.5	1.21
WDM4	2.0	0.15	6.7	0.93
WDM5-N	2.0	0.05	4.9	0.71
WDM5	2.0	0.03	5.1	0.82

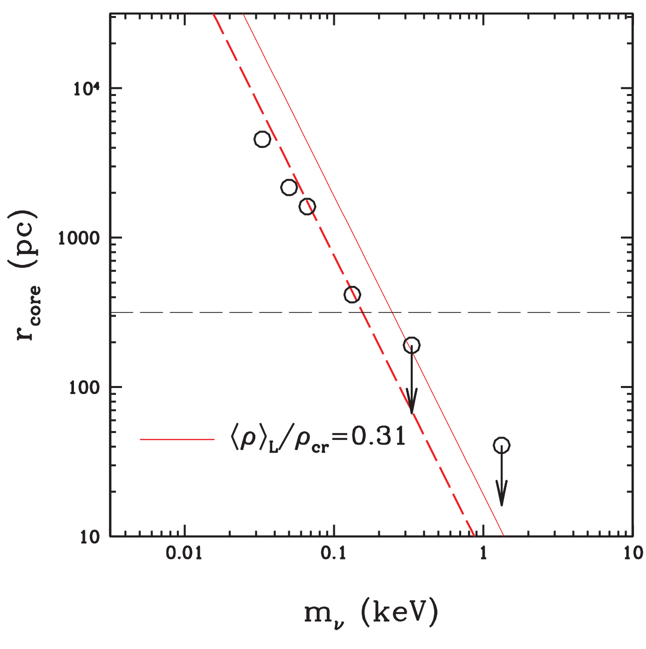

Figure 1. Comparison between core size in simulations (open symbols) and the theoretical expectation for a $M = 10^{12}\,\mathrm{M_\odot}$ halo (solid line). The dashed horizontal line is the gravitational softening of our simulations. All points below this line should be considered as upper limits on the core size. The red dashed line is a linear fit to the simulation results.

The article "Cores in warm dark matter haloes: a *Catch 22* problem" (Macciò et al. 2012) was published in MNRAS, 424, 1105 (2012).

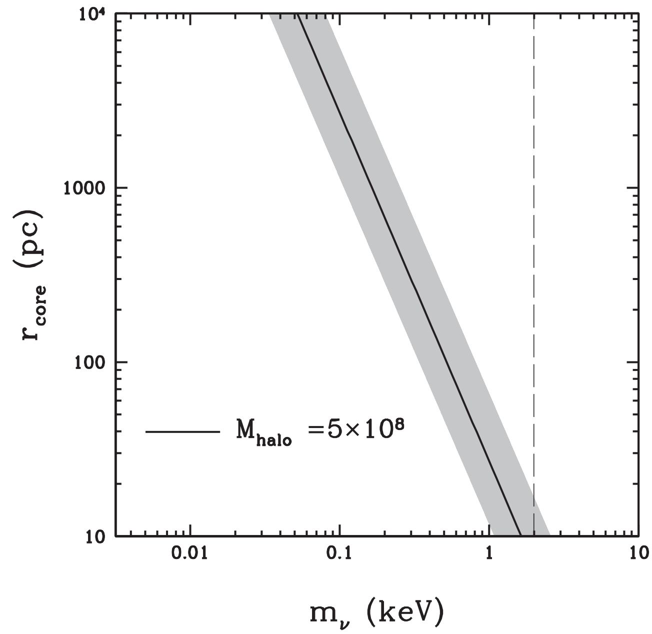

Figure 2. Expected core size for the typical dark matter mass of Milky Way satellites as a function of the WDM mass m_ν. The shaded area takes into account possible different values of the local density parameter $0.15 < \Omega_m < 0.6$. The vertical dashed line shows the current limits on the WDM mass from large scale structure observations.

In the code to create the initial conditions we treated the 3D thermal velocity [equation (4) in the original work] as a one dimensional velocity, overestimating then the velocity by a factor $\sqrt{3}$. The main conclusions, however, do not change significantly.

More specifically, given the relation between the mass of the thermal candidate (m_ν) and the thermal velocity, this implies that the velocities we use in the ICs were for a particle mass lower by a factor $3^{3/4} \approx 1.51$. In Table 1 we list the corrected values of the masses, we have also added a new simulation with the corrected velocities for the $m_\nu = 0.05$ keV case. These new masses for the WDM candidates have an effect on the core size-WDM mass relation, which is shown in Fig. 1 (this figure updates fig. 7 in the printed version of the paper). It is clear that simulations results are not well reproduced by our simple analytic argument based on the pseudo phase space density $Q \equiv \rho/\sigma^3$. We need to reduce the 'theoretical' core estimation by 60 per cent in order to fit the simulation points (red dashed line in the figure). This in agreement with recent results

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by Shao et al. (2012) that also find that Q overestimates the real maximum phase space density.

This even smaller core makes our original statements even stronger, as shown by Fig. 2, where using our new determination of the core size as a function of the warm dark matter mass we compute the expected value of $r_{\rm core}$ for the typical halo mass ($5 \times 10^8\,{\rm M}_{\odot}$) of dwarf galaxies orbiting the Milky-Way (fig. 2).

These new, corrected values for the core size in dwarf galaxies make the conclusions of our paper even stronger, and the "Catch 22" problem for warm dark matter still holds:

If you want a large core you won't get the galaxy, if you get the galaxy it won't have a large core.

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